Thirdly, The reſiſtance on the water, in conſequence of the wheels, and ſhape of the boat.

To the *firſt* it muſt be obſerved, That, while the boat is out of water, it will ever act on a regular plane of caſt iron, and never be ſubject to inequalities, and although the friction will be ſomething more in conſequence of the ſmall wheels, yet, as ſufficient power may be obtained to raiſe her, the friction ariſing from their ſmall diameter will be no conſiderable impediment.

To the *ſecond*, I conceive the wheels are not ſubject to receive injury, but while the boat is out of water; and, even then, I do not perceive wherein they are liable to damage; the wear which enſues by a long courſe of time, only, can affect the boat in this part; and, to this, it muſt be obſerved, that ſhe will not undergo ſo much hardſhip in paſſing two hundred miles, as a common waggon in moving one mile on the uſual roads.—But, even admitting frequent repairs ſhould be neceſſary, ſmall ſlips may be conſtructed at proper ſituations, where a man, by a common windlaſs, would draw the boat out of water, and repair her, with the ſame facility as he would remedy a defect in a cart, or a waggon; the proceſs of dry docks neceſſary to large boats, is by no means required in repairing theſe.

In the *third* objection, the reſiſtance in the water may appear to ariſe from two cauſes; firſt, from the projection of the wheels in ſome degree from the bottom; and, ſecond, from the flatneſs of the boat on the ends. But it muſt be obſerved, that boats of this conſtruction are deſigned to move ſlow, conſequently the reſiſtance ariſing from the particular conſtruction will be very trifling, and of little importance, reſiſtance being much

more

more in proportion to the velocity, than either ſhape or weight.

To give a general idea of this, it is merely neceſſary to remark, that ſhould a man attempt to drive a horſe ſixty miles *per* day, he could ſcarce convey a boat of the lighteſt conſtruction at that rate; yet the ſame horſe would convey one hundred tons twelve miles *per* day with eaſe, and arrive at the end of ſixty miles in five days; which is equal to twenty tons per day moving through the whole ſpace of ſixty miles.

This I hope will be ſufficient to ſhew that reſiſtance from ſhape, in ſlow movements, is inconſiderable; alſo, that the true principle of conveying goods cheap, when expedition is not required, is, to move ſlow and take a quantity*; and in this reſpect I ſhall now conſider their ſuperiority over boats of twenty-five tons.

Seeing

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* To the reader who may wiſh to enter more into the abſtract, it may be proper to remark, that a body moving in a fluid is reſiſted from two cauſes; firſt, from the coheſion of the parts of the fluid: for a body in motion ſeparating the parts of the fluid wherein it moves muſt overcome the force with which thoſe parts coheſe,

The ſecond cauſe is, the *inertia*, or inactivity, of matter; whereby a certain force is required to move the particles from their place, in order to ſuffer the body to paſs. When the ſame body moves through the ſame fluid with different velocities, the reſiſtance increaſes, in proportion to the number of particles ſtruck, in an equal time, which number is as the ſpace run through in that time; *i. e.* as the velocity. But further, it increaſes in proportion to the force with which the body ſtrikes againſt every part; which force is alſo as the velocity of the body; and therefore if the velocity be triple, the reſiſtance is triple, from a triple number of parts to be removed. It is alſo triple from a ſtroke three times ſtronger againſt every particle; therefore the whole reſiſtance is nine-fold, *i. e.* as the ſquare of the velocity; hence a body moving in a fluid is reſiſted, partly in a ratio to the velocity, and partly in a duplicate ratio of the velocity.

Moſt authors have conſidered it as a rule, that while the ſame body moves in the ſame medium, it is always reſiſted in the duplicate proportion of its velocity; that is, if the reſiſted body move in one part of its track with *three* times the velocity with which it moved in ſome

other